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IS : 4209 - 1987

Indian Standard

CODE OF SAFETY IN CHEMICAL LABORATORIES

(*First Revision*)

2007

UDC 542·1 : 614·8

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Gr 5 *June* 1988

Indian Standard

CODE OF SAFETY IN CHEMICAL LABORATORIES

(First Revision)

0. FOREWORD

0.1 This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards on 21 December 1987, after the draft finalized by the Chemical Hazards Sectional Committee had been approved by the Chemical Division Council.

0.2 The need for a code of safety for chemical laboratories stems from two factors, first due to hazards inherent in the nature and handling of chemicals, and second due to hazards from inadequacy or handling of instrumental facilities necessary in chemical laboratories, such as electricity, glassware, machinery equipment, gas, steam, water, apparatus for high/low temperature and pressure. Innumerable chemicals used as reagents and solvents are flammable/toxic/corrosive/poisonous, etc, and are harmful/irritants to body tissues.

0.3 In this revision, more details pertaining to the following are covered:

a) General rules of conduct concerning safety;
b) In laboratory designing, reference for handling highly toxic materials, emergency alarm system, etc, is given;
c) Under organization of laboratory safety details for fire, emergency and rescue procedures; evacuation of site reporting systems are given; and
d) General laboratory techniques and fires under specific techniques are covered elaborately.

0.4 This standard is one of a series of Indian Standards on safety in laboratories. The other standards published in this series are IS : 4906-1968* and IS : 12036-1986†.

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*Code of safety for radiochemical laboratory.

†Code of safety for microbiological laboratories.

1. SCOPE

1.1 This standard recommends a code of safety for chemical laboratories.

1.1.1 This standard does not cover hazards relating to radioactive substances.

2. GENERAL FACTORS INVOLVING SAFETY

2.1 The rules of safety embodied in this standard should be ingrained in every employee so that their practice becomes a matter of day-to-day habit.

2.1.1 It will be the responsibility of the institution/organization to force safety rules. Senior members are required to be vigilant to ensure that adequate infrastructural facilities are available for safe working and adequate information and guidance is available to junior members concerning a variety of chemical work being performed in laboratories. It will also be the responsibility of workers to adhere to safety rules and point out to senior members any unsafe condition/spots prevailing in and around the laboratory.

2.1.2 Every effort should be made to recognize areas of potential hazards and corrective action should be taken at the appropriate time to minimize accidents.

2.1.3 A complete record of accidents should be maintained by the institution to identify causative factors and to provide valuable guidance for the future.

2.2 General Rules of Conduct

2.2.1 Smoking is strictly prohibited in working areas other than those specified.

2.2.2 Reporting to work in an intoxicated condition is strictly forbidden and punishable.

2.2.3 All other activities detrimental in maintaining safety in the laboratory should be strictly prohibited.

2.2.4 Do not work in isolation in a laboratory; a second person should be within call.

2.2.5 Avoid handling or consuming food or drinks in laboratories.

2.2.6 Good personal hygiene is essential.

2.2.7 Good housekeeping is considered as a backbone of laboratory safety. Returning equipments not in use to their proper storage place, clear labelling of chemicals, keeping laboratory floor free of obstruction and other good housekeeping practices should be strictly followed.

2.2.8 A periodic check of windows, storewells, fire appliances, first-aid boxes, etc, in the laboratory should be made.

2.2.9 A suitable fire extinguisher should be located close to each laboratory.

2.2.10 Regard all substances as potential sources of hazards and handle them with care.

2.2.11 Always use safety carriers for transporting glass or plastics containers with a capacity of two litres or greater. Incompatible chemical should never be transported together. They should be transported in suitable separated carriers.

2.2.12 All safety equipment shall be properly labelled and maintained in good operating condition and be regularly checked and inspected for correct operation in accordance with the manufacturer's instructions.

2.2.13 Allowable maximum quantities of dangerous substances, consistent with efficient operation shall be established for each laboratory and never exceeded.

2.2.14 Keep safety information and emergency procedures prominently displayed at all times. Emergency procedures should be posted in each laboratory giving telephone numbers of:

a) Fire brigade,
b) Ambulance,
c) Supervisor/Safety coordinator, and
d) Hospital.

2.2.15 Clean up spills immediately and thoroughly. The nature of spills should be ascertained and spills treated accordingly.

2.2.16 In case of an injury, inform or arrange to inform your supervisor or safety coordinator and take first-aid promptly.

2.2.17 Report all accidents to your immediate supervisor.

2.2.18 If you are in doubt about the safe and proper way to do a job, consult your supervisor.

2.2.19 Report all unsafe conditions and unsafe acts by fellow workers, which are likely to cause as accident, to your supervisor.

2.2.20 In case of an emergency such as a fire, explosion, etc, inform or arrange to inform your supervisor or safety coordinator or head of the department nearest available and follow the laid down procedure.

2.2.21 Keep all the exits free of obstructions to facilitate quick escape in an emergency.

2.2.22 Use proper lift (meant for carrying materials) while carrying dry ice or liquid nitrogen. Liquid oxygen should not be used as a substitute for liquid nitrogen.

2.2.23 Separate cans should be kept to deposit broken glass as otherwise the person cleaning the laboratory can sustain cuts from glass if mixed with waste paper, etc.

2.2.24 Chemicals wastes should be disposed off by proper procedures.

2.2.25 Gas cylinders should never by dragged while transporting when standing, they should be chained to avoid their fall.

2.2.26 In case of fire, use of lift should be avoided.

3. LABORATORY DESIGN FOR SAFETY

3.1 Functional Design — Only those aspects of laboratory design which are relevant to make them safe places of work and are pertinent to accident hazards have been discussed in this standard. A laboratory is not a haphazard collection of rooms; but a well planned and designed building, where each room has a definite function and whose arrangement relative to the others also serves a definite objective. Thus in the design of each room as also of the whole laboratory there has to be a proper appreciation of the purpose. It is important that, in the planning of the laboratory, there should be consultation and collaboration between the architect and the engineer on the one hand, and the senior workers in the laboratory on the other. Even in old laboratories quite a lot may be achieved by minor alterations and adjustments to make them safe places for work.

3.1.1 *Laboratory Rooms* — The design of the laboratory will depend upon the specific needs of a particular laboratory. Thus, student laboratories should normally consist of large rooms, where a number of students can work, while a research or specialized analytical laboratory should consist of separate small units. From safety point of view the bay layout is preferable to separate suite of rooms because, in case of an accident, there is a greater chance of some other worker being in sight. Moreover, every laboratory should be provided with a few minimum necessities to ensure safety in working. If possible, each laboratory room shall have two easily accessible exits

(a fire escape if a second door cannot be provided). If a bay layout is provided for each semi-enclosed cubicle, there should be an escape arrangement from the side away from the work benches. The arrangement of immovable fittings should be such as to provide adequate moving space between benches. There should be no fittings on the floor which would hinder or obstruct free movement. The design and arrangement of benches will naturally vary according to the function of each laboratory but adherence to certain minimum requirements would go a long way to reduce accidents. Benches should not be too deep (widely accepted width is 75 cm) and the service line controls should be placed at the front below the bench top. The reagent shelves should be easily accessible and should not be unduly high. The reagent shelves should be provided with beading (and with centre partitions in the case of double-side shelves) to prevent bottles falling off due to vibrations.

Wherever possible, flame-proof electrical fittings should be provided in the laboratory especially where large amount of solvents are handled. Laboratories should also be provided with adequate ventilation and efficient exhaust to prevent the build-up of the concentration of toxic vapours in the atmosphere.

3.1.1.1 *Ante-rooms* — A chemical laboratory should have, besides the actual laboratory rooms, separate rooms for : (a) doing pressure reactions and other hazardous operation, (b) overnight reactions, (c) chromatography, and (d) work involving large quantities of solvents. These rooms should preferably be located at the end of the main laboratories. The furniture used in the rooms should be made of fire resistant material and the room should be provided with exhaust fans.

3.1.2 *Fume Cupboards* — Each laboratory should be provided with efficient fume cupboards, sufficiently large to permit complete enclosure of apparatus normally used, and provided with a sink for the washing of apparatus used for handling toxic materials. For laboratories where large number of digestions are to be carried out, a separate ante-room equipped with efficient fume cupboard may be provided. The cupboard should not be too deep so that the fittings inside are easily accessible while the controls of the service connections should be provided outside. The fume cupboard should have corrosion-proof fittings. It should be provided with a light, so placed that the whole cupboard is illuminated. The shutter pans should be made of shatterproof or reinforced glass. The front shutter should be provided with small windows so that apparatus can be manipulated through these without lifting the shutter. The cupboard should be so designed that there is strong upward draught even when the shutter is open and there is no chance of any fumes entering the laboratory; this can be achieved by having baffle at the back. In rooms where work with extremely poisonous gases is done, it is advisable to have an air inlet at the bottom (balanced-draught cupboard) so arranged as to sweep everything to the exhaust. It is desirable to have at least one such cupboard in every chemical laboratory. For fume cupboard, the exhaust fan should be able to create a free velocity of 30 metres per minute at normal working height. Cupboards for highly toxic materials require higher face velocities. Hot concentrated perchloric acid should be handled in separate fume cupboards where its vapour do not contact any organic matter.

3.1.3 *Service Connections* — All pipe lines in the laboratory should be differently coloured as specified in IS : 2379-1965* and each room of the laboratory should be provided with main valves at an easily accessible and prominently visible places so that, in an emergency, all services to a room can be cut-off from one point. There should also be arrangements for cutting-off the service connections of the entire laboratory from one place.

Sinks and drains should be made of chemically resistant materials and the drains should be properly trapped and vented. It would indeed be false economy to use chemically non-resistant materials for the purpose of minimizing expenditure, thinking that there will be no occasion to discharge highly corrosive liquids into the sinks. It may happen that sooner or later, a lead drain installed for a weak effluent may have to carry concentrated nitric acid with disastrous results. The sinks should, wherever feasible, be flushed with liberal quantity of water after the contents from reactions vessels are discharged into them. Water immiscible solvents must not be poured in drains.

Similarly, draining boards should be made of, or at least covered, with non-absorbent material. Drain boards made of wood absorb chemicals easily and tend to give vapours for a long period.

3.1.4 *Laboratory Furnishings* — Furnishing (curtains, etc) which will easily catch fire should be avoided. Fire resistance properties of materials used for these should be carefully checked.

3.1.5 *Stores* — Where large quantities of explosive materials (but not explosives), inflammable substances, solvents or gas cylinders are to be stored, reference should be made to rules and regulations in force. The store should be provided with separate ante-rooms for keeping : (a) explosive materials, (b) inflammable substances, (c) poisonous substances, (d) solvents in bulk, (e) gas cylinders, and (f) acids. Care must be taken that incompatible materials are stored separately. Stores storing flammable solvents and chemicals should have flameproof equipment including switches conforming to IS : 2148-1981*.

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*Specification for colour code for identification of pipe line.

Both the main stores and its ante-rooms should be well lighted and well ventilated with proper exhausts to prevent build-up of the concentration of toxic agents. The ante-rooms should preferably be small separate blocks; however, if they have to be part of main stores building, their exit and entrance should be towards the outside of the main store rooms, and these rooms should be well protected from heat and direct sunlight. The electric light fittings should conform to IS : 2206 (Part 1)-1984†. Smoking shall not be permitted in the stores. Utmost care should be taken in the issue of bulk items these should never be directly poured from carboys or drums but always be siphoned out. Explosive materials like sodamide, picric acid, etc, should be handled gently and carefully. Suitable equipment and materials should be kept handy to deal with any spillage problems.

3.2 Emergency Alarm Systems

3.2.1 A fail-safe emergency alarm system which is audible in all parts of the building should be available in all chemical laboratories.

3.2.2 The alarm system should be periodically tested for operational performance and audibility in the specified range.

3.3 Safety Equipment — The following items should be available as protective equipments in all chemical laboratories. The main items are:

a) *Safety Glasses/Face Shields* — Eye protection at minimum level implies normal spectacles if worn; otherwise safety goggles.
b) *Aprons* — Various types of aprons are available like PVC, rubber or cotton to protect against specific hazards.
c) *Gloves* — Wear protective gloves to handle chemicals (rubber, PVC, etc). To handle sharp objects use gloves made out of leather, canvas, etc.

Other items for specialized protection should be available and all personnel must be aware of their location and use. They are:

a) Fire blankets,
b) Eye wash devices,
c) Safety showers,
d) Breathing apparatus,
e) Positive pressure hoods,
f) Helmets,
g) First-aid kit, and
h) Gas masks.

All the personal protective equipment for common use should be kept in their proper places, cleaning them thoroughly after use.

A defective equipment should be immediately replaced.

4. ORGANIZATION OF LABORATORY SAFETY

4.1 The nature of the organization required for implementation of good laboratory practice in a chemical laboratory will depend on the size of the establishment and the nature of the work carried out. However, regardless of the size, every laboratory worker should be imparted at least a basic training on safety with regard to health and safety hazards of chemicals, and the hazards which may occur from the equipment and techniques one is likely to employ.

4.2 No employee or laboratory worker shall commence work involving highly dangerous materials or processes without first acquainting himself with the appropriate safety practices.

4.3 Fire, Emergency and Rescue Procedures — Emergencies in a chemical laboratory call for prompt action. Procedures to be adopted in case of emergencies should be clearly defined and posted in a prominent place. Periodic appraisal of the circumstances which can lead to emergency situation will reveal many avoidable problems.

4.4 Evacuation of Site — Apart from fire, other situations such as spilling of chemicals, leaking cylinders of toxic and corrosive gases also may require evacuation of personnel.

4.5 Reporting Systems — All accidents should be reported without delay to the laboratory supervisor or safety coordinator with all essential details to ensure prompt action.

4.6 Safety Awareness — A survey of industrial accidents has shown that a very large majority of accidents is due to human factors and can, therefore, be avoided. The two most important causes are ignorance of precautions to be taken and disregard of safety rules. On the average, younger workers are more likely to have accidents. For eliminating these causes, proper instructions are necessary; but written rules and regulations, and safety equipment by themselves are not enough to ensure safety in laboratory.

4.6.1 The first essential is to create an atmosphere of constant care and attention to even the smallest detail. This cannot come by itself but should be nurtured and developed by the person in-charge, who should set an example, and insist on its being followed by everybody else. Each newcomer should be trained to reach and then live up to the standard already set. In most

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*Specification for flameproof enclosures of electricals apparatus (*second revision*).

†Specification for flameproof electric lighting fittings: Part 1 Well-glass and bulkhead types (*first revision*).

laboratories, while care and accuracy are the primary considerations, speed is often of importance and there might be a tendency for even sufficiently trained staff to take chances. This should be discouraged at once, not only by the immediate associates of a newcomer but by those in charge, who should never consider this important.

4.6.2 In some schools or technical colleges, the students will have been imparted some rudiments in safe working. It will be useful to include in students' practical curriculum a course in 'Safety in chemical laboratories'. The students should be required to fit up different types of glass apparatus after the procedure had been demonstrated by a laboratory assistant. This also applies to the working of electric circuits and many other kinds of laboratory work.

4.7 Handling of Apparatus

4.7.1 *Glassware* — A laboratory worker should always be aware of the fact that glassware is likely to break if handled roughly. The importance of handling glass apparatus in the proper manner cannot be over-emphasized. While setting up an apparatus, it is necessary to ensure that all pieces are clamped and supported properly, different components may fall apart even with the smallest bumping and endanger both the experiment and the worker.

4.7.2 When cutting, tubing or rod, make a simple cut at the point of fracture with a triangular file or a cutter. Place a cloth over the glassware to protect the hands. Then, holding the tube or rod with the thumbs together, opposite the cut, bend the material towards the body. A clean, right-angle break will almost always be obtained, but the cloth should always be used to guard against an odd accident.

To cut large-bore tubing, loop round a piece of Nichrome wire at the point of fracture. Heat the wire electrically, and while hot, allow a few drops to fall on it. This causes the glass to break.

All glass fractures should at once be fire polished in a Bunsen flame so as to round off the sharp corners, especially in case of glass tubing which is to be pushed through a rubber bung. When this is done, the size of hole in the bung should allow the glass to pass through with reasonable ease, after the glass has been lubricated with water or glycerine. The tube should be held in a cloth or leather gloves should be worn. The bung should not be held in such a way that the glass tube may be pushed into the hand holding the bung. The same care should be taken when withdrawing a glass tube or rod from a bung. If difficulty is met with, push a cork borer, of the size which will just pass over the tube into the bung, between the tube and the bung. Then withdraw the tube from inside the cork borer. If the tube is broken off short, it is better to scrap the bung.

4.7.3 Winchesters should be carried in suitable carriers made of wood provided with suitable handles. A cage should always be provided while using vacuum desiccator.

4.7.4 When glass containers have been used, they should be cleaned by the person who has used them. This ensures that other workers will not be endangered by small amounts of any harmful material remaining in the container. It is absolutely necessary that apparatus handed over for glass blowing has been cleaned thoroughly.

4.7.5 Test tubes should be held properly with test-tube holder while heating with the mouth pointing away from others and oneself, and should not be more than half full while being heated. Pipettes should not be left so that their ends protrude across the front edge of benches. While pipetting, always use pipette fillers (propipettes).

4.7.6 Wash-bottles or Winchester bottles made of colourless glass should not be left on benches where direct sunlight may fall, because they may act as lenses and focus sunlight on certain spots and cause fire. Such instances have been reported in literature. Also the windowsil area should be free of any apparatus/bottles.

4.7.7 The laboratory floor should be kept free of any glass apparatus or glass bottles containing chemicals.

4.7.8 *Electrical Apparatus* — When using electrical apparatus, see that it is as leakproof as possible and properly earthed. New furnace packing may be damp and the furnace should be run for some hours at a moderate temperature until it is quite dry. The floor near electrical apparatus shall be dry and the workers shall not touch the apparatus with wet hands. Insulated wire should be used for all electrical connections. Electrical apparatus which produce even the slightest shock presents a potential danger and shall be disconnected and checked up immediately.

Care should be taken to use only right kind of electric fuses. The fuse in use should be of appropriate current rating and lighter than the one installed by electrical staff in the mains wiring system. If it fails, fit another to make sure that the fuse itself is not faulty; should this also fail, go through the circuit carefully, and if the fault cannot be found, call in the electrical staff. At no time the fuses of higher rating should be used.

Charge accumulators in a separate room, not on a laboratory bench where a nearby spark or flame might cause the evolved gases to explode. With a glass accumulator such an accident can be quite harmful. Acid accumulators should be charged some distance away from the place where nickel iron accumulators, using an alkaline electrolyte, are charged. The mixing of the two electrolytes could have very serious consequences.

All leads should be kept as short as possible. Electrical cables should never be allowed to come in contact with hot surface, which would burn the insulation, cause a short-circuit and create a fire hazard. No water points or rubber connections should be kept near the electrical plugs and switches; it is best to fix all electrical fittings at a small height over the bench, either against the wall or on the reagent rack so that accidental spillage of water on the bench cannot get to the electric connections.

4.7.9 An electric hair-drier should never be used to hasten the evaporation of an inflammable liquid, the coil can get over-heated and thus cause ignition of the vapours.

4.7.10 Electricity is dangerous and care should be taken while using it. Literature reports death at 60 volts AC.

4.8 Working with Chemicals

4.8.1 All chemicals could be regarded as dangerous. A chemical could be explosive, corrosive, flammable or a poison under certain circumstances.

4.8.2 Always use the safety appliances recommended while handling chemicals and avoid skin contact with chemical substances.

4.8.3 Chemical should only be used when the drums, sacks, containers or pipelines containing them are clearly labelled and their identity confirmed. In case of doubt, or when a mix-up has actually occurred, inform your supervisor immediately.

4.8.4 Avoid spillage of chemicals by careful handling. Keep suitable materials to chemically treat spillage, if necessary.

4.8.5 Ensure that the jubilee clips are properly fixed while transferring chemicals through rubber, PVC or teflon hoses.

4.8.6 It is advisable to keep a water hose close by, whenever a chemical's transfer through drums, carboys, etc, is being performed (not in case of water sensitive chemicals).

4.8.7 Chemicals storage must always be done after considering their compatibility. Once a place for storing a particular chemical is fixed, it should not be altered without purpose.

4.8.8 Observe precautions concerning handling of chemicals as given in **2.2** and use safety equipment as given in **3.3**.

4.8.9 The containers of chemicals that are highly volatile or decompose or are moisture sensitive should be carefully opened.

4.8.10 Whenever chemicals are transferred to new containers, all relevant details should be transferred to labels on new containers.

5. GENERAL LABORATORY TECHNIQUES

5.1 If it is necessary to continue an experiment overnight, leave precise and adequate information to night shift assistants or security staff.

5.2 Use proper equipment for experiments carried out under reduced or elevated pressure.

5.3 Vacuum flasks and desiccators should be regularly checked for signs of damage.

5.4 All experiments involving use of toxic chemicals should be carried out in a fume cupboard.

5.5 Use a cloth for protection when inserting glass tubing, rods or thermometers into bungs or tubing. Use a lubricant where necessary.

5.6 Compressed gas cylinders, when standing upright, should always be properly supported.

Never connect a gas cylinder directly to the apparatus, always interpose a system of traps.

Always turn off a gas cylinder at the main valve after use and release any excess pressure in the regulator.

Be sure that your condenser tubing does not become trapped.

Make sure that all rubber connections to a condenser are well secured.

5.7 Refrigerators should be defrosted regularly. Highly volatile/inflammable chemicals should not be stored indefinitely in the refrigerator, unless suitably modified by removing the bulb and the thermostat outside the refrigerator cabinet.

On no account must any food or drink be kept in laboratory refrigerators.

5.8 Labels on reagent bottles should not be altered or tempered with.

5.9 Nitrogen should be preferred to air on all capillary bleeds as a large number of organic substances oxidize at high temperatures.

5.10 Use proper stirring system after taking the volume of the flask into account.

6. SPECIFIC TECHNIQUES

6.1 Solvent Extraction and Solvent Stripping — If extraction is carried out in a separating funnel, release the pressure at frequent intervals by inverting the funnel with the stopper securely held and opening the top with care. Point the funnel away from the eyes and naked flames.

6.1.1 Always ensure that the condensing systems are adequate to cope with solvent use.

6.1.2 Dialkyl ethers, tetrahydrofuran, etc, form peroxides in contact with air and sunlight. They should be stored in dark bottles.

6.1.3 Do not attempt to distil solvents nearly to dryness since these concentrates may contain explosive peroxides.

6.1.4 Naked flame should not be used for reactions involving inflammable solvents.

6.2 Vacuum Distillation

6.2.1 Distillation under reduced pressure should always be carried out behind adequate shields.

6.2.2 Always use a suitable trap between the sources of vaccum and the apparatus.

6.2.3 Evacuate the apparatus and check for leaks before commencing heating. Avoid heating by direct flame.

6.2.4 Never subject the apparatus to rapid changes of pressure; at the end of distillation, allow it to cool before slowly admitting air.

6.2.5 Do not use water-cooled condenser if the distillate is entering the condenser above 160°C.

6.3 Organic Preparative Reactions

6.3.1 Special conditions must be complied with for experiments continued outside normal working hours; leave special instructions to the night shift assistants or security staff.

6.3.2 Make sure the stirring gear is in good order before starting an experiment. Do not restart a stirrer if it has been stopped for any length of time in a heated reaction flask; allow it to cool first.

6.3.3 Condenser capacity should be in excess of requirements. Always make provisions for rapid removal of the heating source.

6.3.4 In order to study the behaviour of new experiments, limit the size to the minimum in case of the following:

a) First time experiments;

b) Experiments with alkali metals, cyanides, etc;

c) Halogenations, alkylations;

d) Reactions involving fluorine, HF, BF_3, etc;

e) Reactions involving alkylene oxides;

f) Polymerization reactions;

g) Nitric acid oxidants;

h) Reactions involving the use of H_2O_2 at 50 volumes or above; and

j) Exothermic reactions.

6.3.5 Add a boiling aid to a liquid well before its boiling point.

6.3.6 The bench should be kept dry in the vicinity of an experiment involving alkali metals. Ensure that it is impossible for pieces of the metal to fall into water or oil baths during addition.

6.4 Pressure Reactions — Utmost care should be taken in carrying out sealed tube reactions. When the pressure is likely to develop, a sealed tube should never be filled up more than one-third of its volume. The initial runs should be done with very small quantities of reactants. Sealed tubes should be protected by a steel tube or a wire cage and the temperature should be raised gradually. These reactions should be carried out in a separate room behind a safety screen. Before opening the tube, it should be well-cooled in ice, tip is then blown off with a pointed flame and when the pressure has been released, the tube may be cut. Autoclave and other pressure vessels should be set up in separate rooms and not in the general laboratory. The autoclaves should have safety valves in proper working conditions.

7. MEASURES IN CASE OF ACCIDENTS

7.1 Information regarding an accident should reach supervisor/safety coordinator or any other authority as early as possible.

7.2 General — In spite of all precautions, accidents sometimes occur and it is then necessary to take immediate steps to help the injured persons, and to do everything possible to prevent further damage. Only those on the spot can take a decision as to which of these objectives is more important. If there is little risk or condition of the injured becoming serious, it might be necessary to send for a doctor, and to apply first-aid as the first job. In case of a hazardous situation, it may be advisable to summon fire-fighters and to warn others in the building.

7.2.1 It is, of course, imperative that, at the earliest possible moment, all sources of danger shall be eliminated. If the trouble is electrical, switch off the mains. If a fire has broken out, turn off the gas at the main, and switch off the electric power so that, if insulation is burned off from wires, an electrical fire may not start. Remove them, if there are supplies of combustible materials in the laboratory or put them away from the source of danger. Leaking containers of poisonous gas or liquid should be removed to the open air after wearing self-contained breathing apparatus and labelled 'Dangerous'. Somebody should be posted to guard and to see that no one goes near them.

7.2.2 While every effort is being made to make the laboratory safe, it is equally important to bring all possible help to those who are injured. The doctor should be summoned at once, and pending his arrival, those who are trained in first-aid should give immediate treatment to those injured. In any case, remove the victims to fresh air and keep them warm and at rest. If there is a fire, or a risk of fire, they should be removed out of danger zone.

7.2.3 The actual treatment to be given would have to be decided upon by the persons carrying out first-aid, as there may be two or more kinds of injury, such as a cut or asphyxiation and a bruise. Some first-aid treatment for more common injuries are given in 7.4.

7.2.4 As soon as the situation permits, the details of the accident should be entered in the Accident Book. It should not be overlooked that a full description including minor details about an accident might throw light on its causes and measures could be taken for prevention of such accidents in future.

7.3 Fire Safety

7.3.1 The most important factor for fire prevention in the laboratory is our conduct. The rules involving smoking, electrical work, open flames, handling flammable material and static electricity should be strictly followed. Fire fighting equipment and emergency exits should be kept clean and ready for immediate use. Emergency siren should also be in working condition.

7.3.2 Good housekeeping will do much to prevent fires. Proper disposal of waste material and clean up of spillage are essential. Flammable waste should be stored in glass or metal containers and not in paper or wooden barrels.

7.3.3 If a fire starts on the job, raise alarm and simultaneously use the fire extinguisher in your area to bring down a small blaze and try to extinguish fire before arrival of plant fire squad. A delayed alarm may cause the loss of precious minute and allow a fire to grow to such proportions that it may destroy the entire building, in spite of all efforts of organized fire fighting forces.

7.3.4 In the event if a fire occurs and is extinguished without an alarm being sounded, immediately notify to the fire/security officer. This will enable them to inspect the area and replace any fire extinguisher that may have been emptied.

7.3.5 Unless a person is a member of the plant fire squad or belong to the laboratory, DON'T GO NEAR FIRE, it will only cause obstruction and may endanger him and others.

7.3.6 Every person should be able to recognize the different types of fire and learn the right kind of extinguisher to use. The details of different classes of fires and types and number of fire extinguishers required for each area/section are given IS : 2190-1979*.

7.3.7 Each person may be required to use fire-extinguisher if a fire starts. Speed is essential in fighting a fire, as an ordinary combustible fire can multiply itself fifty times in eight minutes. With oil, grease, paint and inflammable solvents, even seconds are precious. Most fires start small and can be confined, if acted promptly.

7.4 First-Aid — First-aid must be provided in any chemical laboratory. However minor, an injury always must be attended to and first-aid be given/taken. Incidents arising as a direct result of work performed are avoidable if one observes the principles of safe working conditions. Failure to observe safe working principles results in accidents. No matter how minor an incident, it will need proper examination and corrective measures to avoid recurrence of such incidence. Constant supervision and improvement of working methods is the best defence against the occurrence of hazards.

7.4.1 Information regarding the location of *First-Aid* and *First-Aider* should be displayed in all places of work. All laboratories should maintain prescribed number of first-aid boxes containing copy of leaflet giving advice on first-aid treatment. First-aid boxes should contain sufficient number of sterilized, unmedicated dressings of various sizes, adhesive wound dressings, plaster, sterilized absorbent cotton, eye pads, approved eye ointment and safety pins. In addition, eye wash bottles with clean water should be placed at strategic points.

7.4.2 *Affected Eyes* — Observe the following rules, if eyes are affected by chemicals (*see* Note).

a) Thoroughly wash the eyes with large quantities of gently running water from a tap or wash-bottle for 10 minutes.

b) Make sure that the water bathes the eye ball by gently opening the eye lids and keeping them apart till the treatment is complete.

c) Arrange for transport to hospital for immediate medical attention and treatment of eye injury. Information regarding the chemical should accompany the patient.

NOTE — For hydrogen fluoride, hydrofluoric acid or related compounds, *see* 7.4.6.

7.4.3 *Skin Contact* — Observe the following rules if skin is affected by chemicals (*see* Note).

a) Flood the affected skin thoroughly with large quantities of running water for at

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*Code of practice for selection, installation and maintenance of portable first-aid fire extinguishers (*second revision*).

least 10 minutes, or till satisfied that no chemical is in contact with the skin. Use of soap will facilitate the removal of chemicals insoluble in water.

b) Remove all contaminated clothings of the casualty ensuring that the person removing the clothing is not contaminated during the process.

c) If necessary, arrange for transport to a hospital or to a doctor for medical attention. The information regarding the hazardous chemical along with details of first-aid given should accompany the casualty.

NOTE — For hydrogen fluoride, hydrofluoric acid or related compounds, *see* 7.4.6.

7.4.4 *Inhalation of Vapours/Gases* — Observe the following rules if vapours or gases are inhaled (*see* Note).

a) Remove the affected person out of the danger area to fresh air.

b) Loosen clothing.

c) If the affected person is unconscious, put the casualty in a face down position and watch to see if breathing stops.

d) If breathing has stopped artificial respiration by the mouth-to-mouth method should be applied. In case of HCN gas only use the Silvester method.

e) Remove the person for immediate medical aid to a hospital accompanied with information on the chemical and details of first-aid given.

NOTE — For hydrogen cyanide, *see* 7.4.7.

7.4.5 *If Ingested* — Observe the following rules in case of ingestion:

a) If the chemical is confined to the mouth, large quantities of water should be given as a mouth wash to the casualty.

b) If the chemical has been swallowed, dilute the chemical by giving copious drinks of water or milk.

c) Do not induce vomitting.

d) Arrange for transport to hospital for medical attention giving information regarding the chemical swallowed, its concentration and quantity, if possible along with details of first-aid given should accompany the casualty.

7.4.6 *Special Treatments (for Hydrogen Fluoride, Hydrofluoric Acid or Related Compounds* — These chemicals cause destructive and extremely painful burns on tissues when they come in contact. Immediate action should be taken, if splashed.

a) *Splashes in the eye* — Splashes of hydrogen fluoride or hydrofluoric acid in the eyes must be treated immediately by flooding for at least 15 minutes with large volumes of gently running water from a tap. The urgent removal of patient to hospital is essential since failure to treat correctly may result in loss of eye.

b) *Splashes on the skin* — Remove all contaminated clothing and flood the skin with large volumes of running water. Thereafter 2 percent calcium gluconate gel should be applied liberally to the affected parts and massaged into the skin till medical aid is available. If nails have been penetrated by the acid the gel be liberally applied over and around the nail and the area, and massaged continuously for at least 15 minutes. All cases of hydrogen fluoride or hydrofluoric acid splashes must be referred to hospital after washing the skin and starting the above treatment with the ointment.

7.4.7 *Special Treatment for Hydrogen Cyanide* — Observe the following rules in case of hydrogen cyanide inhalation:

a) Remove the casualty from the place of accident or from the neighbourhood of the gas taking care that rescuer does not fall a victim to the same gas.

b) If conscious and breathing, remove the patient immediately to the hospital.

c) If breathing stops, place the casualty in the prone position with the mouth down with a clear breathing passage. Give artificial respiration by the Silvester method. Do not use the mouth-to-mouth method because the first-aider may inhale the hydrogen cyanide gas himself. Artificial respiration should be given by a trained first-aider.

7.4.8 *Electric Shock* — Switch off the current. If the victim is unconscious or has stopped breathing, begin artificial respiration without delay. Continue until the first-aid group arrives.

7.4.9 *Unconsciousness* — Always place victims on their sides to prevent suffocation.

7.4.10 *Broken Bones, Dislocations* — Keep the victim still. Do not manipulate the injury.

7.4.11 *Shock, Heart Attack* — If the face is white, place upper part of the body in low position. If the face is red, place upper part of the body in a high position.

7.4.12 *Convulsions/Fits* — Lay the patient down carefully, protecting his head with a pillow or clothing.